BE90

STANDARDS DEVELOPMENT BRANCH OMOE
3693600006709

ONTARIO

A Summary Report on Water Quality in the Penetang–Midland–Pt. McNicoll Waubaushene Area of Georgian Bay 1971

TD
227
.P46
S86
1971
MOE

Copyright Provisions and Restrictions on Copying:

This Ontario Ministry of the Environment work is protected by Crown copyright (unless otherwise indicated), which is held by the Queen's Printer for Ontario. It may be reproduced for non-commercial purposes if credit is given and Crown copyright is acknowledged.

It may not be reproduced, in all or in part, part, for any commercial purpose except under a licence from the Queen's Printer for Ontario.

For information on reproducing Government of Ontario works, please contact Service Ontario Publications at copyright@ontario.ca

TD
227
.P46
S86
1971

A summary report on water quality in the Penetang-Midland-Pt. McNicoll-Waubaushene area of Georgian Bay / Veal, D.M.

78416

GEORGIAN BAY
Ref. 72885

ENTERED JUN 24 2003

MOE
Standards Development Branch
LIBRARY

A SUMMARY REPORT ON WATER QUALITY IN

THE PENETANG-MIDLAND-PT. McNICOLL-WAUBAUSHENE

AREA OF GEORGIAN BAY

This report was originally prepared by
D. M. Veal, M.F.P. Michalski, A. R. Clark
Biology Branch

and

M. Jones
Bacteriology Branch

Division of Laboratories
ONTARIO WATER RESOURCES COMMISSION
1971

Reprinted May, 1973

17799

Information for the following summary report has been extracted from a comprehensive report which is in preparation. Detailed information on survey procedures and results can be obtained by writing to the Director, Division of Laboratories.

While the report is based on data collected during 1969, there have been no significant improvements in the quality of waste discharges to the study area and the description of water quality should be representative of conditions in 1971.

CONCLUSIONS

Studies of algal populations and bacterial quality in the Penetang-Waubashene area of Georgian Bay carried out during May to October, 1969, revealed deteriorating water quality conditions in Penetang Harbour and Midland Bay. Relatively high levels of blue-green algae production during late summer periods suggest that this entire area is somewhat more productive than Lake Huron proper.

Every effort must be made to curb further inputs of nutrients (particularly phosphorus) to this restricted portion of Georgian Bay. Causes of the relatively high phosphorus concentrations in the Wye River and the Coldwater - North River system require further assessment.

Nutrient concentrations in the Severn River should not be allowed to increase. Since the Severn River drains Sparrow Lake, Lakes Couchiching and Simcoe, it is important that nutrient loadings to these lakes be minimized. Cottagers and residents in the area can play an important role in preventing nutrient pollution by using soaps and phosphate-free detergents and by making certain that any wastes from individual treatment units are not reaching the local waterways.

Increased attention to the monitoring of bacterial conditions at public beaches in Penetang Harbour and Midland Bay is warranted during the summer swimming season. Samples collected should be analyzed for total coliform, fecal coliforms and fecal streptococci.

INTRODUCTION

In recent years, the Ontario Water Resources Commission has received complaints about algae problems in the Penetang-Midland area of Georgian Bay. As a result of this public concern, a study was begun in 1969 to determine the status of water quality in the area, to define sources of nutrient pollution and to recommend corrective measures which would optimize protection of the aquatic resource. Major emphasis was placed on determining the reasons for the excessive production of algae.

Another aspect of water quality to which attention was devoted was a study of bacterial conditions. High populations of pathogenic (disease-causing) bacteria may cause water to be unfit for swimming and other recreational activities. The presence of high numbers of bacteria of intestinal origin may be indicative of raw or improperly-treated sewage gaining access to a watercourse.

In addition to the studies of algae and bacteria, supporting data were collected on water chemistry (e.g. nigrogen, total phosphorus, carbon dioxide, oxygen), physical aspects (temperature, turbidity), and other biological measurements (bottom fauna, Cladophora evaluation). Most measurements were made on a bi-weekly basis from May to October, 1969.

Figure 1 illustrates the study area and the locations of the eleven main sampling locations that were utilized.

RESULTS AND DISCUSSION

The results indicated that water quality throughout most parts of the study area was good. There were however, two areas, namely Penetang Harbour and Midland Bay, which were over-enriched and periodically experienced undesirable levels of disease-causing bacteria. Penetang Harbour was affected to the point where pollution was distinctly visible and Midland Bay had visible manifestations of nutrient enrichment.

Algal Development

Measurements of algal production and density of standing crops of algae reflect the effects of nutrient enrichment. Table 1 illustrates the average concentrations of algae (in * areal standard units per ml) found in the study area. The mean phytoplankton concentration found throughout most of the study area was somewhat higher than the levels found in Lake Huron-Georgian Bay proper, which indicates that the entire Penetang-to-Waubaushene area is somewhat enriched. However, with the exception of Penetang Harbour, the average summer levels were below 800 a.s.u. so that no significant problems were presented to people using the water throughout most of the study area. On the other hand, in Penetang Harbour the phytoplankton concentrations

* One areal standard unit (a.s.u.) = 400 u^2

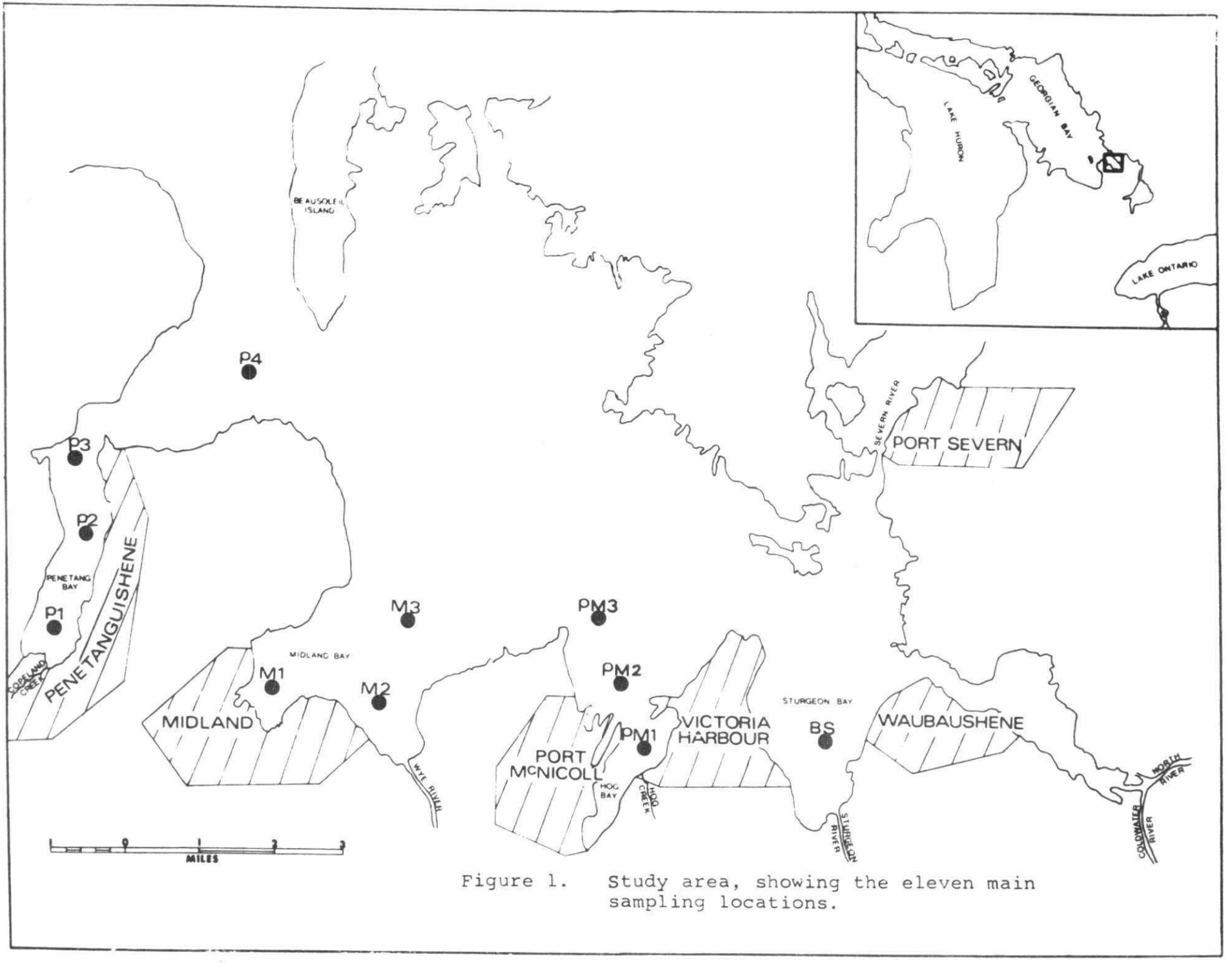


Figure 1. Study area, showing the eleven main sampling locations.

TABLE 1. Summary of phytoplanktonic data collected from the eleven sampling locations.

Sampling location	Number of samples	Areal standard units per millilitre		
		Maximum	Minimum	Mean
P1	12	9577	1066	3026
P2	12	5549	483	2373
P3	12	7551	391	2131
P4	12	2507	281	740
M1	12	2855	181	671
M2	12	2457	300	736
M3	12	1777	243	632
PM1	12	1102	134	392
PM2	12	2241	232	685
PM3	12	2321	233	656
BS	10	511	54	245

TABLE 2. Loadings of phosphorus and nitrogen to the study area

Source	Number of samples	Median N concentration (ppm)	Median P concentration (ppm)	*Estimated mean annual flow	Gross loadings (tons per year) N	Gross loadings (tons per year) P	Net loadings (tons per year) N	Net loadings (tons per year) P
Penetang S.T.P.	6	9.9	3.7	0.32	6	2	6	2
Ontario Hospital S.T.P.	4	17.1	4.8	0.06	2	<1	2	<1
Midland S.T.P.	5	21.8	6.2	1.32	52	15	52	15
Copeland Creek	7	0.72	0.02	10	7	<1	3	0
Wye River	8	0.85	0.06	78	66	5	39	3
Hog Creek	7	0.63	0.04	22	14	1	6	<1
Sturgeon River	6	0.83	0.02	44	36	1	21	0
North River + Coldwater Creek	3	0.90	0.06	305	270	18	166	12
Severn River	11	0.40	0.02	813	320	16	40	0

* S.T.P. effluent volumes as million gallons per day
Creek and river volumes as cubic feet per second

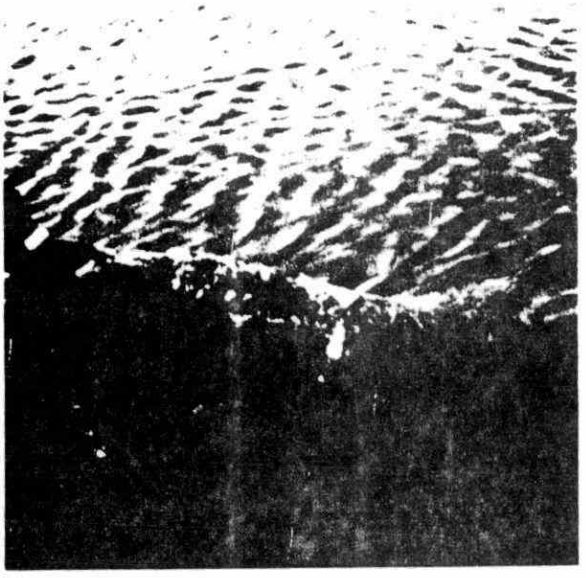


Figure 2. Growth of the alga Cladophora on a log located about 100 feet from the effluent of the Penetanguishene Sewage Treatment Plant.

were almost as high as those in the over-enriched Western Basin of Lake Erie. These high levels in Penetang Harbour greatly decreased water clarity and often gave the water a soupy-green appearance.

While the average summer concentrations of phytoplankton were troublesome only in Penetang Harbour, fall blooms of blue-green algae (Aphanizomenon) were prevalent in both Penetang Harbour and Midland Bay, and recent observations show that these blooms extend as far east as Pt. McNicoll. The blooms have recently been so severe in the past two years that some local residents reported a mass spillage of green paint on the water. Indications are that algae blooms are a recent phenomenon (except for Penetang Harbour) which indicates that nutrients have just recently reached nuisance levels in the Midland area.

The other algae problem which affected local parts of the study area was that caused by growths of the filamentous green alga, Cladophora. This algae grew quite luxuriously on rocks and wooden piers in Penetang Harbour as well as in the vicinity of the waste outfalls of the Ontario Hospital and Midland (see Figure 2) It was restricted to the local areas of nutrient 'build-up' and if nutrient inputs to the study area are not controlled, the spread of Cladophora will undoubtedly be a major factor in depreciating the aesthetic quality of this recreational area.

Nutrient Enrichment

Owing to the aforementioned algal problems, considerable effort was devoted to an assessment of nutrient concentrations and sources within the study area. This summary report will deal mainly with the nutrient phosphorus for the following reasons:

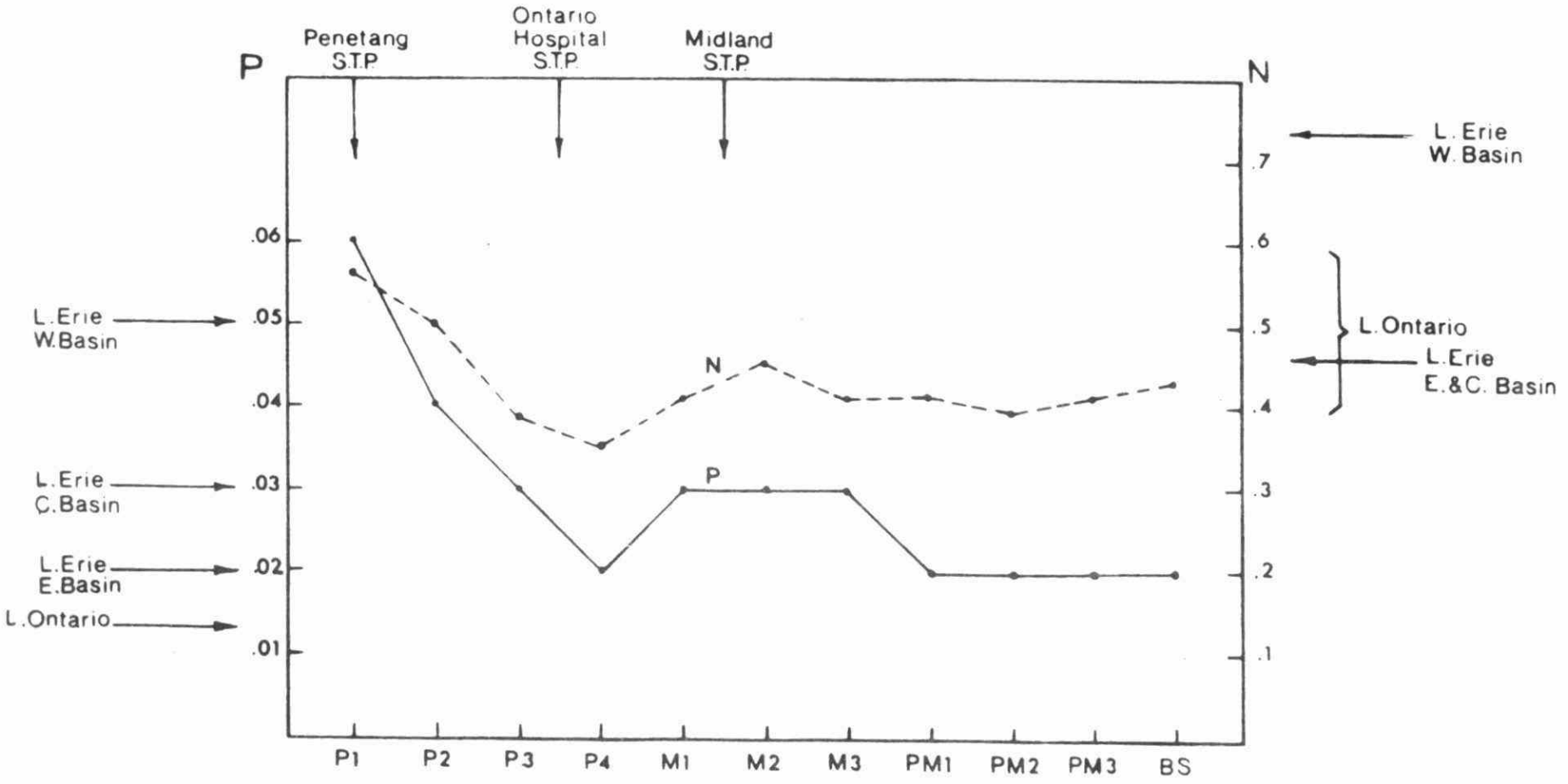
(1) Phosphorus is an important algal nutrient which has recently been identified as being the primary element responsible for the over-enrichment of the Lower Great Lakes.

(2) Phosphorus concentrations best account for the variations in algal production throughout the study area.

(3) It is now technologically and economically feasible to remove phosphorus from waste discharges.

Figure 3 illustrates the mean summer concentrations of total phosphorus and nitrogen in the study area and comparisons are made with average concentrations in Lake Erie and Ontario. The total phosphorus concentration throughout most of the study area was 0.02 ppm.* Midland Bay, however, contained 0.03 ppm and the concentration in Penetang Harbour varied from 0.03 to 0.06. It is evident from these data that the total phosphorus levels in Midland Bay and Penetang Harbour have been elevated above the background level of 0.02 ppm.

* All phosphorus and nitrogen values are expressed as parts per million P and N respectively.


Penetang S.T.P
Ontario Hospital S.T.P
Midland S.T.P
P
N
.06
.05
.04
.03
.02
.01
.7
.6
.5
.4
.3
.2
.1
N
P
L.Erie W.Basin
L.Erie C.Basin
L.Erie E.Basin
L.Ontario
L.Erie W. Basin
L.Ontario
L.Erie E.&C. Basin
P1
P2
P3
P4
M1
M2
M3
PM1
PM2
PM3
BS

A significant part of the survey was devoted to an evaluation of all the major algal nutrient sources entering the study area. Comparisons can readily be made between nutrient sources by calculating the loading (e.g. tons per year) from a waste source or river to the receiving lake. This concept of comparative nutrient loadings is essential in the management of nutrient removal programs as primary emphasis should be devoted to reducing inputs from major sources. The study area is physically similar to a discrete lake as the only significant connection with Georgian Bay proper is the narrow channel on the west side of Beausoleil Island. Therefore, it was possible to evaluate nutrient loadings on a net loading* basis which has recently been described by Johnson and Owen (2). Table 2 illustrates the net loadings of phosphorus and nitrogen to the study area from all significant sources. The only major contributor of nutrients to Penetang Harbour is the Penetang municipal sewage effluent. Copeland Creek contributes no net phosphorus to the harbour and only 2 tons/yr. of nitrogen. The Penetang sewage treatment plant contributes 2 tons/yr. of phosphorus and 6 ton/yr. of nitrogen.**

* The amount of nutrient contained in the input in excess of the amount of nutrient displaced in the equivalent volume of water.

** This estimate is probably low since by-pass of <u>combined</u> sewage was not taken into consideration.

Table 2 illustrates also that the only major net contributors of nutrients to the area east of Penetang Harbour are: 1) the Midland S.T.P. effluent, 2) the Wye River and 3) the North River, plus Coldwater Creek. The contribution from the Ontario Hospital is small because of the small volume (0.06 - 0.1 m.g.d.) Net loadings from Hog Creek and the Sturgeon River are low because of their small discharge volumes and low nutrient concentrations. The Severn River provides no net phosphorus contribution and only a small amount of nitrogen because of its low nutrient concentration.

Midland's municipal sewage effluent is the largest net contributor of phosphorus to the area between Penetang Harbour and the Severn River, and the second largest contributor of nitrogen. This waste source contributes 48% of the phosphorus entering this area and 16% of the nitrogen. The Wye River contributes 10% and 12% respectively of the phosphorus and nitrogen entering the area. The North River plus Coldwater Creek combination contributes 36% of the phosphorus and 50% of the nitrogen. The reason for the rather large net contributions from the Wye River and the North River-Coldwater Creek system is basically unknown, although the malfunctioning of septic tanks at Wyebridge and Coldwater is expected to be contributory.

It must be pointed out that water quality of the outer parts of the study area will be determined

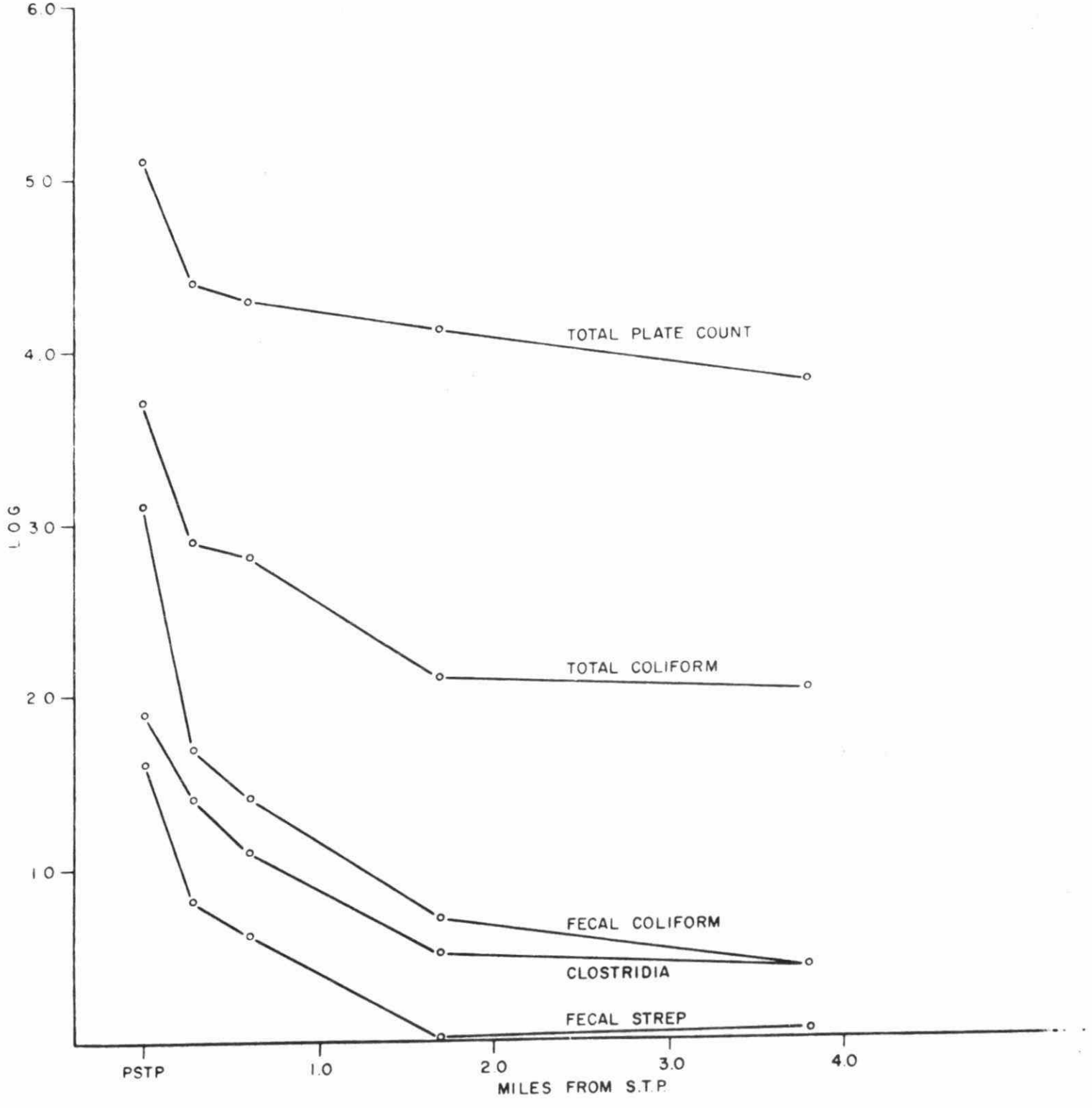
largely by the quality of water entering from the Severn and Coldwater-North rivers. These two river systems make up 90% of the volume of water entering the study area. The flushing rate for the area is approximately one year and it is therefore evident that even a small increase in nutrient concentrations in either of these river systems could rapidly produce an associated change in the major part of the study area. The Severn River contributes about 65% of the flow into the area and it is important that the quality of water in the Trent System, which drains into the area via the Severn, be kept clean.

Bacteria

Bacterial analyses indicated generally satisfactory conditions throughout most of the study area. Penetang Harbour, however, supported high numbers of coliform and fecal coliform bacteria which periodically exceed the OWRC criteria* for recreational waters. Figure 4 illustrates the decrease in bacteria with increasing distance from the Penetang Sewage Treatment Plant. Causes of the periodic problems with bacteria relate to the by-passing of raw sewage at Penetang's sewage plant which frequently is over-

* Recreational waters can be considered impaired when the coliform, fecal coliform, and/or enterococcus geometric mean density exceeds 1000, 100 and/or 20 per 100 ml, respectively determined on a series of at least 10 samples per month.

Figure 4. Bacterial densities in Penetang Bay - Geometric Means versus Distance.

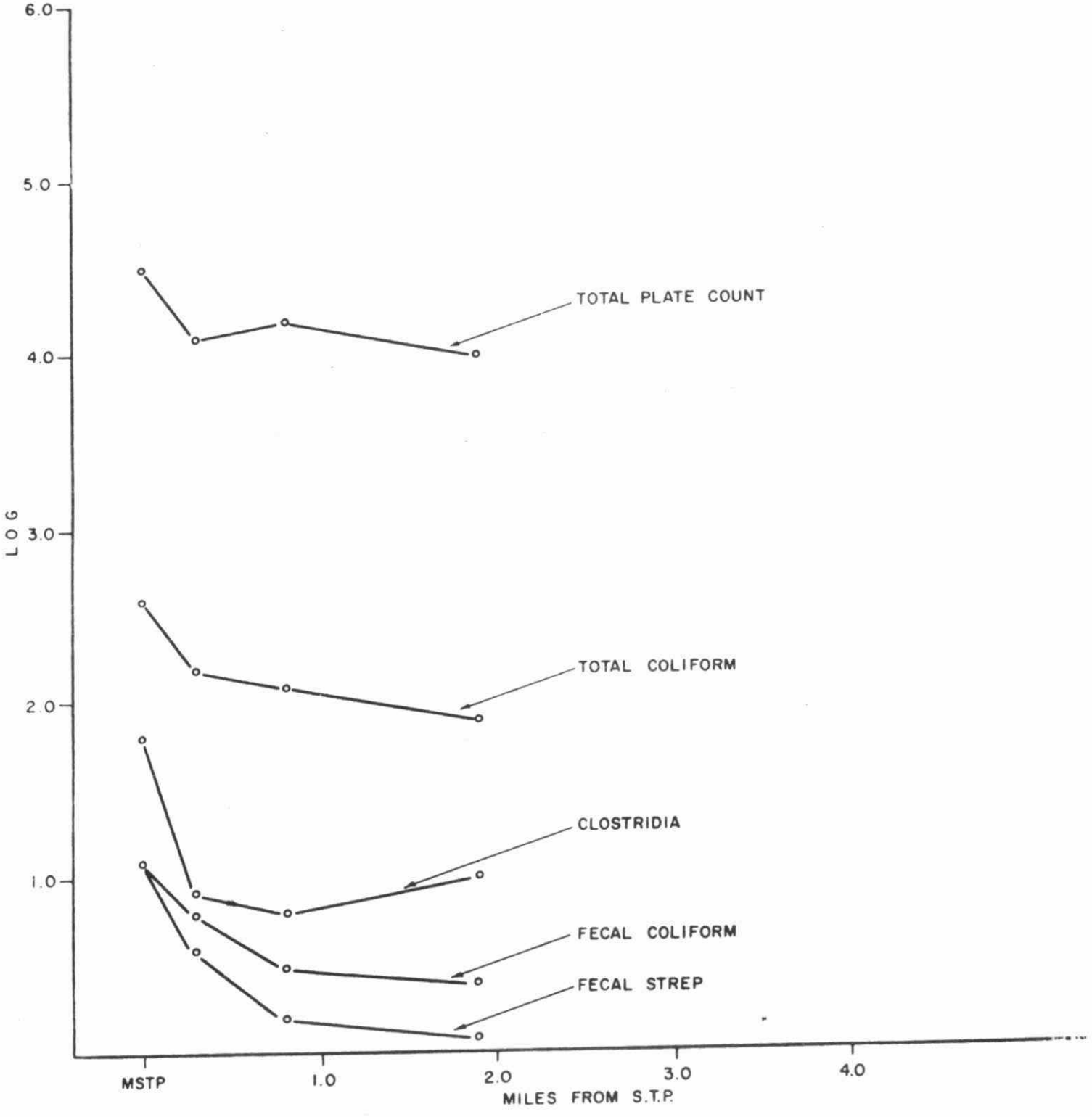


loaded during periods of high rainfall and spring runoff. Penetang, like most other Ontario towns, has a system of combined storm and sanitary sewers and the plant is frequently overloaded with storm water. Because the plant provides secondary treatment (activated sludge process), the operator must be careful not to overload the plant and thereby wash out the sludge. As a result, a combination of storm water and raw sewage by-passes the plant during rainy periods. While by-pass volumes are not measured, a recent OWRC report (3) indicated that a greater volume (estimated at 200 million gallons combined sewage in 1970) actually by-passed the plant than was treated (120 million gallons raw sewage in 1970). However, it is likely that the actual sanitary sewage in the combined by-pass was about 12 million gallons.

In Midland Bay, populations of coliform bacteria were much lower and except for station MSTP,* seldom exceed OWRC standards. Fecal coliform and fecal streptococci bacteria were always within OWRC standards except in the immediate vicinity of the sewage treatment plant outfall (Station MSTP). Figure 5 illustrates the decrease in bacteria with increasing distance from the sewage plant outfall. The results indicate that both Midland's sewage

* Station MSTP and PSTP were located in the immediate vicinities of the Midland and Penetang sewage plant effluents respectively.

Figure 5. Bacterial densities in Midland Bay - Geometric Means versus Distance.



and the Wye River probably contribute to the bacteria in Midland Bay. Fortunately, the by-passing of sewage is infrequent at Midland (about 18 days in 1969) and this no doubt is why the bacterial situation near Midland is much better than in the vicinity of Penetang.

ACKNOWLEDGEMENTS

Mr. Ken Browne and Mr. Steve Hunter (OWRC summer students) collected the samples and made field measurements and conducted analyses. Miss Ingrid Weichmann and Mrs. Dianne Sanderson of the OWRC Bacteriology Branch provided laboratory assistance and Mr. D.B.W. Reid of the University of Toronto School of Hygiene assisted with the statistical analyses. Phytoplankton samples were analyzed by various staff members of the OWRC Biology Branch. The Chemistry Branch conducted most of the chemical analyses. Mr. Jim Murray, Mr. Don Picotte and Mr. Doug Edwards, operators of the sewage treatment plants at Midland, Penetang and the Ontario Hospital respectively, provided samples of the plant effluents and assisted in determining discharge volumes.

References

1. International Lake Erie Water Pollution Board and the International Lake Ontario-St. Lawrence River Water Pollution Board. 1969. Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River. Volume 1 - Summary. 150 p.

2. Johnson, M.G. and G.E. Owen. The role of nutrients and their budgets in the Bay of Quinte, Lake Ontario. OWRC report. August, 1970. 24p.

3. Ontario Water Resources Commission. Status of water pollution control in the Town of Penetanguishene, 1970. 59 p.

4. Ontario Water Resources Commission. The Georgian Bays Survey - Bacteriology Section. July, 1970. 43 p.

MOE
Standards Development Branch
LIBRARY

TD
227
.P46
S86
1971

A summary report on water quality in the Penetang-Midland-Pt. McNicoll-Waubaushene area of Georgian Bay / Veal, D.M.

78416